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Effect of nitrogen- and potassium-based fertilizers on nitrogen fixation in the winged bean, *Psophocarpus tetragonolobus*

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Introduction

The family Leguminosae comprises around 20000 species belonging to 650 different genera but only 15% of these have been studied and on a global scale it is estimated that leguminous plants annually fix 80 million tons of nitrogen (Anon. 1984). Winged bean has an extraordinary capacity to nodulate and fix large amounts of nitrogen. Masefield (1957) quantified and demonstrated that the number and mean fresh weight of nodules per plant of winged bean surpassed that of all other common tropical grain legumes, including soybean. This report was confirmed by Karikari (1978). A remarkable record on winged bean nodulation was observed by Masefield (1961), when he found a 109-day-old plant with 627 nodules (= 585 g fresh weight). Though such potential exists, a fresh weight of 20 g (Masefield 1957) and 68 nodules per plant (Wong Kai Choo 1957) are considered to be more realistic.

Basic studies carried out on the effect of major nutrients on winged bean have shown the effect of N and K to be generally positive (unpublished data). Of the winged bean cultivars tested in Sri Lanka, 'SLS-40' has given highest yields, while 'SLS-44' is attractive because it produces white-coloured seeds. This study was therefore undertaken to examine the effect of N and K fertilizer on N-fixation in these two cultivars.

Materials and methods

This study was conducted at the International Winged Bean Institute, Pallekele, Kundasale, Sri Lanka (Immature Brown Loam Soil), with 890 to 1015 mm annual rainfall. The treatments included varieties ('SLS-40' and 'SLS-44'), urea (0, 10, 20, 30 and 40 kg N/ha) and K^+ (0, 32.5 and 65 kg K^+/ha). Urea (46% N) was applied

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thrice, basally and at 30 and 60 days after sowing. KCl (approx. 50% K^+) was applied basally as per treatment. All plots received a blanket dressing of superphosphate (20% P) at 43.7 kg P/ha, at the time of planting. All fertilizers were applied along the rows of plants, except the basal which was broadcast. This experiment was a 5 × 3 × 2 factorial, arranged in randomized complete block design with three replicates per treatment and the plot size was 4.2 × 3.6 m. Two plants were removed from each plot at 15-day intervals, commencing from 30 until 90 days after sowing (d.a.s.). The nodule number, nodule dry weight, shoot and root dry weights were recorded and the acetylene reduction activities of the root systems of uprooted plants were measured (Upchurch 1987). A separate ANOVAR table was prepared for each character for different d.a.s. and the least significant difference was calculated. Correlation values between nitrogenase activity per hour and nodule number and nodule dry weight were calculated.

Results

Nitrogenase activity was inhibited with increase in combined N (Fig. 1). Although the inhibition by combined N was related to the amount of N added, the most significant drop in activity was from 0 to 10 kg N/ha. This was seen clearly up to 75 d.a.s. On 90 d.a.s. the overall activity was low and the inhibition due to combined N was not so apparent.

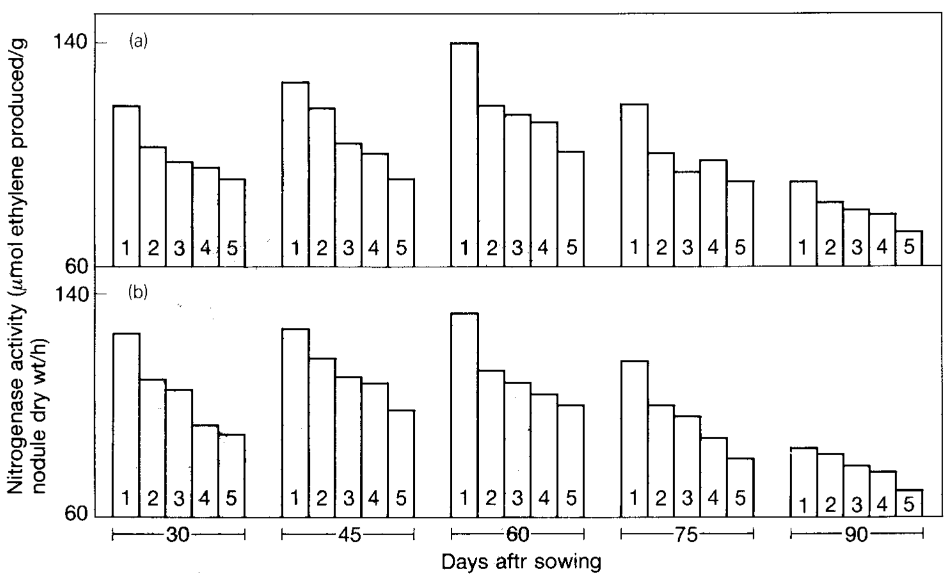

Fig. 1 The effect of combined nitrogen on the specific nitrogenase activity in winged bean: (a) 'SLS-40'; (b) 'SLS-44'. 1, 2, 3, 4 and 5 = 0, 10, 20, 30 and 40 kg N ha^{-1}.

The relationship between nitrogenase activity and nodulation is shown in Fig. 2. The correlation of nitrogenase activity was closer to the dry weight of nodule (r = 0.9742) than to nodule number (r = 0.8424). This indicates that the nodule biomass was more reliable than nodule number, as an indicator of nitrogenase